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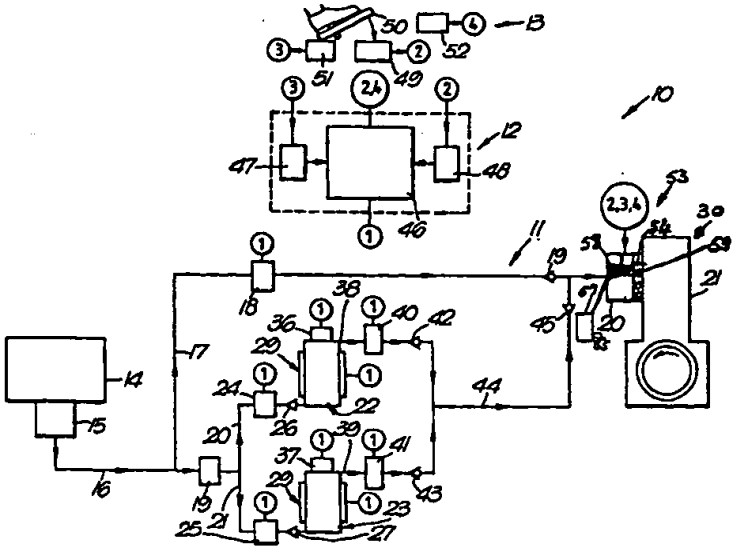

WO9512066

ENGINE FUEL METERING AND STEAM REFORMER SYSTEM

NICKTOWN PTY. LTD. SMITH, Noel

Inventor(s): ;SMITH, Noel

Application No. AU9300629 , **Filed** 19931208 , **A1 Published** 19950504 ,

Abstract:

An engine fuel metering and steam reformer system (10) has several vapour vessels (22, 23) in parallel. As one vessel (22, 23) receives liquid fuel from a tank (14) via a pump (15) and vaporizes the fuel using a heating means (29), the other vessel (22, 23) supplies vaporized fuel via a main vapour line (44) to the engine steam reformer system (54) to mix with water vapour, delivered from a water vapour radiator system (53). After conversion of the fuel vapour and water vapour to hydrogen, this fuel is then delivered to the engine (21) by vacuum drawn through the system (10). The system (10) is controlled by an electronic logic control system (12), which has a microprocessor (46) connected to sensors (36, 37, 49, 51, 52) and which controls the operation of temperature compensated control valves (18, 24, 25, 40, 41) via temperature compensated liquid level monitors to control the flow of fuel in the system (10).

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Priority: AU PM 1994 19931026

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Foreign Abstract: Système (10) de contrôle d'alimentation en carburant et de reformage à la vapeur pour moteur qui comporte plusieurs réservoirs (22, 23) de vapeur en parlallèle. Tandis qu'un réservoir (22, 23) reçoit du carburant liquide provenant d'un réservoir (14) par l'intermédiaire d'une pompe (15) et vaporise ledit carburant à l'aide d'un dispositif de chauffe (29), l'autre résevoir (22, 23) fournit du carburant vaporisé par l'intermédiaire d'une conduite de vapeur principale (4) au système (54) de reformage à la vapeur pour moteur de manière à mélanger ledit carburant avec de la vapeur d'eau fournie par un système (53) à radiateur de vapeur d'eau. Après conversion de la vapeur de carburant et de la vapeur d'eau en hydrogène, ce carburant est ensuite acheminé vers le moteur (21) par aspiration à travers le système (10). Ledit système (10) est commandé par un système (12) de commande logique électronique qui comporte un microprocesseur (46) connecté à des capteurs (36, 37, 49, 51, 52) et qui commande le fonctionnement de soupapes (18, 24, 25, 40, 41) de commande à compensation de température par l'intermédiaire de dispositifs de surveillance du niveau liquide à compensation de température pour réguler le flux de carburant dans le système (10).


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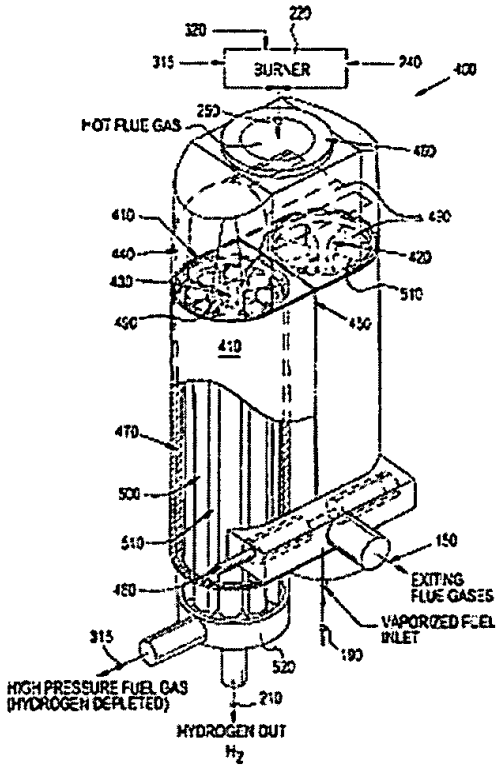

Family Lookup

US5938800

Compact multi-fuel steam reformer

McDermott Technology, Inc.

Inventor(s): ;Verrill, Christopher L. ;Chaney, Larry J. ;Kneidel, Kurt E. ;McIlroy, Robert A. ;Privette, Robert M.

Serial No. 969824 , **Filed** 19971113 , **Issued** 19990817

Abstract:

A compact, mobile fuel converter for producing molecular hydrogen from hydrocarbon fuels, such as automotive gasoline, or other fuels such as methanol and ethanol has a steam reformer for producing molecular hydrogen from a pressurized and desulfurized fuel and water vapor preheated by flue gases from the fuel processor. The fuel processor is fed with the desulfurized fuel and water mix and a burner is provided to combust off-gas from the fuel processor reaction. Uncombusted off-gas is depressurized and mixed with auxiliary fuel used in the burner. Hydrogen produced in the fuel processor by the steam reforming process is separated from other reformate products using membrane filtration.

US.Class: 0481279 0481185 422211

IPC: NotAvailable B01J00816

US Patents Cited: 5207185 5299536 5437123 5441546 5525322 5546701


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(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

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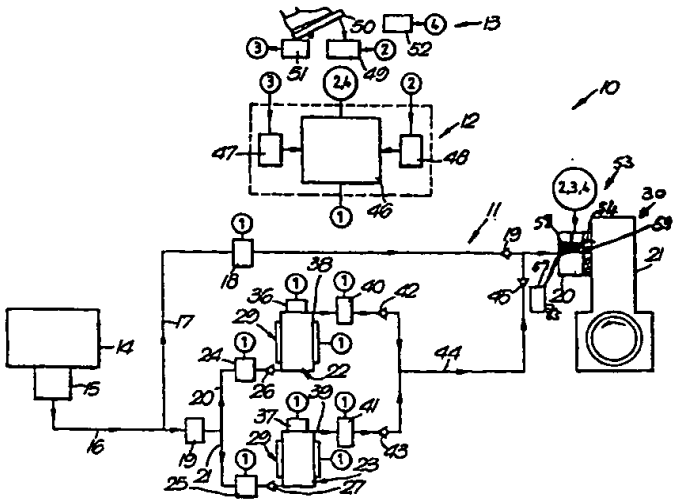
(54) Title: ENGINE FUEL METERING AND STEAM REFORMER SYSTEM



(57) Abstract

An engine fuel metering and steam reformer system (10) has several vapour vessels (22, 23) in parallel. As one vessel (22, 23) receives liquid fuel from a tank (14) via a pump (15) and vaporizes the fuel using a heating means (29), the other vessel (22, 23) supplies vaporized fuel via a main vapour line (44) to the engine steam reformer system (54) to mix with water vapour, delivered from a water vapour radiator system (53). After conversion of the fuel vapour and water vapour to hydrogen, this fuel is then delivered to the engine (21) by vacuum drawn through the system (10). The system (10) is controlled by an electronic logic control system (12), which has a microprocessor (46) connected to sensors (36, 37, 49, 51, 52) and which controls the operation of temperature compensated control valves (18, 24, 25, 40, 41) via temperature compensated liquid level monitors to control the flow of fuel in the system (10).

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Title: "ENGINE FUEL METERING AND STEAM REFORMER SYSTEM"

BACKGROUND OF THE INVENTION

(1) Field of the Invention

THIS INVENTION relates to a method of monitoring fuel and metering water vapour and fuel vapour into a steam reformer system, on an engine,

The invention may be applied to internal combustion engines which operate on liquid hydrocarbon fuels (e.g. petrol, gasoline, benzine diesel, kerosene and the like) or other liquid fuels but is particularly suitable for petrol engines.

(2) Prior Art

An engine designer faces three, sometimes conflicting, goals. The engine should have good power and/or torque characteristics, low exhaust emissions and good fuel economy.

It is known that "lean burn" engines which operate at high air/fuel ratios (e.g. of the order of 18:1) have low emission levels and good fuel economy but they often have poor and unacceptable performance characterisitcs.

Conventionally, when a petrol engine is fitted with a fuel injection system, fuel is supplied to the injectors via a fuel rail with one outlet per injector to supply fuel through the injectors into the combustion chamber of an internal combustion engine. In recent years, injectors have become controlled with the use of a micro-processor and a common fuel rail, fitted to each injector to aid fuel to be supplied to the engine in its correct proportion according to demand from the engine.

Unused fuel from the fuel rail is returned to the fuel tank, via a vacuum control valve depending on demand of the engine.

To enable leaner air/fuel mixtures to be used, it now has been proposed to introduce the fuel into the engine in vapour form as the finer droplets in the fuel mist (fuelet) are more easily ignited than the fuel droplets, with a wide size distributor, supplied by a carburettor or fuel injection systems. It is also proposed to introduce fuel in vapour form to an engine steam reformer system fitted to the engine exhaust manifold. Some examples which supply the fuel in vapour form include the patent specifications AU 11982/67 (506950) (Little etal); AU 28171/77 (Barber); W082/03660 (JEB Energy Research Inc.); W085/03330 (onics Inc.) and WO87/01766 (Noel Claude Smith).

To date no such vapour supply system has proved commercially acceptable.

SUMMARY OF THE PRESENT INVENTION

It is an object of the present invention to provide an engine fuel supply system where the liquid fuel is supplied to the engine and to the engine steam reformer system as a vapour and to reform the steam to a combustable fuel.

It is a preferred object of the present invention to provide such a system where the air/fuel mixture may be lean.

It is a further preferred object of the present invention to provide such a system where the vapourization of the fuel and the supply of the vapour into the engine steam reformer system is effected in 3 stages.

It is a further preferred object of the

present invention to provide a system where, at full throttle, heated fuel is supplied direct to the engine for maximum power.

More preferred objects of this invention will become apparent from the following description:

In one aspect the present invention resides in an engine fuel supply system including: several vapour vessels; pump means to supply liquid fuel from a supply to the vapour vessels; means to heat the vapour vessels to cause at least a portion of the liquid fuel in the vapour vessels to be vapourized; and means to supply the vapourized fuel into the engine steam reformer system and deliver the reformed combustable fuel to the intake of an engine; wherein:

The vapour vessels are arranged in parallel; and temperature compensated control valve means are provided to selectively connect the vapour vessels to the pump means and the vapour supply means so that while one vapour vessel is connected to the vapour supply means to supply the vapourized fuel to the engine steam reformer system, the other vapour vessels are disconnected from the vapour supply means while the liquid fuel in the other vapour vessels are being vapourized.

In practise this invention uses fuel by vapourising it and to mix this fuel with steam for conversion to a combustable fuel, inorder to drop fuel usage of a vehicle, with the use of temperature compensated control valves/ monitors and modified fuel injectors controlled by a micro-processor, for fuel injected engines.

The present invention (drawing Fig. 1) has been devised to incorporate temperature compensated control valves attached to the fuel inlet of the fuel injection system and controlled by a micro-processor to give four stages, stage 1 - super economy, stage 2 - economy, stage 3 - power, and stage 4 - super power and to meter water vapour into an engine steam reformer process system, to convert it into steam as it flows through the engine steam reformer system and monitor fuel into a pair of vapour vessels so as the vapour from the vapour vessels can be metered to mix with the steam in the engine steam reformer, to create crude hydrogen from this fuel vapour and steam and supply it to the engine as it's fuel.

In an experimental unmodified "Nissan powered RB30E" Holden Commodore, the fuel consumption was 11.3 L/100 (25m.p.g). With the same vehicle modified using this system, it acheived a fuel consumption of upto 3.8 L/100 (74m.p.g).

Other objects and advantages will become apparant from the following description:

In order that the invention may become readily understood and put into practical effect, referance will now be made to a preferred embodiment of the invention wherein:-

The fuel vapour vessels are sealed units with an inlet and an outlet (drawing Fig. 2). Fuel is pumped to each vapour vessel which is monitored to the correct level by a temperature compensated electronic liquid measuring device, which sends a measage back to the micro-processor, to stop fuel from entering the vapour vessels, via a temperature compensated

control valve. The fuel in the vapour vessels are heated by exhaust gases flowing through heat coils immersed in the fuel inside each vapour vessel. In addition heat is transfered from the exhaust manifold, or other heating means. Using a diaphragm vapour pump, fuel vapour is pumped from one vapour vessel to mix with the steam in the engine steam reformer system. When this vapour is used, fuel vapour is then pumped from an other vapour vessel to mix with the steam in the engine steam reformer system. A timer switch changes from one vapour vessel to the others, in sequence, those being charged while the other is being used. During cold start of the engine, unused stale fuel is purged from the vapour vessels back to the fuel tank and fresh fuel is pumped to the vessels ready to vapourise.

The total steam reformer system consists of a water container (20 liters or more), a water preheating transfer radiator system, plates of carbon steel fabricated to fit between the exhaust manifold and cylinder head of the engine having a series of pipes horizontaly through it and with direct exhaust gases that flow through the series of pipes to the inlet manifold, which accepts water vapour from the radiator through a ventury tube into the engine steam reformer system, inorder to convert the water vapour into a steam condition where the tendancy of the hydrogen and oxygen becomes separated. While the steam is being carried along the series of pipes, with the flow of exhaust gases, fuel vapour is introduced, wherein the hydrogen and carbon becomes

separated. With both oxygen and carbon now separated from the hydrogen (in the engine steam reformer) then the oxygen readily joins with the carbon, which results in both of these gases becoming carbon dioxide ($C - O^2$). The hydrogen out of both the fuel and the steam is now left floating free to run the engine.

In practise, the engine steam reformer system creates a fuel of crude steam, containing hydrogen, carbon dioxide, some unreacted water vapour some unreacted fuel and some unstable carbon monoxide. This fuel of crude steam, runs the engine during idle/super economy and economy (stage 1 & 2). During economy, for power, extra fuel is introduced into the engine steam reformer via a temperature compensated control valve.

When further power is required (stage 3) fuel vapour, from the vapour vessels, is stopped. A small measure of fuel is now supplied to the injectors via a heated fuel rail and temperature compensated control valves, which supplies fuel to mix with the steam in the inlet manifold of the engine. During super power (stage 4) the temperature compensated control valves, opened electro-magnetically, allows delivery of extra fuel to the injectors, which mixes with the steam at the engine intake manifold for use. Operations of these four stages, are controlled by the micro-processor which relates directly via sensors to the accelerator pedal of the motor vehicle (drawing Fig. 1).

The fuel rail (drawing Fig. 6) is manufactured to have outlet nipples, one per

injector, to supply fuel through the injectors to the engine, into the base of the inlet manifold, to mix with the steam from the engine steam reformer system. A tube for heating runs through its centre. This carries hot exhaust gases, drawn through by engine vacuum, from the exhaust manifold and branches off to flow into the air intake of the inlet manifold, which heats both the fuel rail and the air within the inlet manifold. The circumferance of the inner heat tube is smaller in size than the circumferance of the fuel rail tube, enough to allow fuel to flow in between the inner and outer tubes, to restrict the volume of fuel, within the fuel rail, to readily heat as this fuelet enters the fuel rail. This fuelet is delivered into the fuel rail through temperature compensated control valves, controlled open or closed by the micro-processor.

Typical application of each or some of the temperature compensated control valves, is as follows;

A temperature compensated control valve has a movable plunger within the valve body, which may be controlled electro-magnetically to open or shut, controlling the fuel flow to the injectors and also the flow of fuel vapour and water vapour to the engine steam reformer system. The base of the plunger has a seal, when closed rests on a seat, to be held in the closed position by a spring, one end of which is located in a recess in the top of the plunger with the opposite end of the spring protruding from its recess, which presses on the spring landing. The amount of movement of

the plunger is controlled by the ajuster on top of the valve body, for adjusting and fine tuning the spring. The electro-magnetic means is activated by applying a voltage thereto (to pull on the plunger within the control valve) to open the plunger off its seat. The spring, pushing down on top of the plunger, urges the plunger towards the closed position. The base of the plunger is fitted with a soft seal of fuel resistant material, to enable the plunger, to seal against the seat at the inlet of the control valve. A small bore angely from top to bottom of the plunger allows pressure from the outlet side to enter through the plunger into the void and close it against the seat. This stops fuel, fuel vapour and water vapour from entering their respective designations.

In practise, as temperature increases, heat is transfered to the spring and the plunger, which expands them so as to push onto the seat, within the control valve, tending to close the plunger, which causes less fuel, fuel vapour or water vapour to enter the control valve. A temperature compensating bias spring situated in the control valve between the seal end of the plunger and the seat, prevents the plunger from fully closing, by applying counter tension on the plunger, which avoids total stoppage of fuel supply. Simultaneously heat tends to cause the fuel to convert into vapour increasing the pressure on the top of the plunger, which closes it, until the vapour is consumed, thereby releasing the internal pressure on the piston which allows the plunger to re-open to let a small amount of fuel to re-enter the

control valve.

In summary, fuel pump pressure tends to move the plunger off its seat and allows fuel to enter via the control valve. Simultaneously heat causes this fuel to vapourise, and enters into the void where the spring is situated (which pressurises the void) and increases the internal down force on the plunger in sympathy with the spring and reduces or stops fuel from entering until the vapour is consumed and or pressure drops. To compensate for heat build up within the control valve from the heating means, a temperature compensating bias spring situated between the seal end of the plunger and the seat, prevents the plunger from fully closing by applying counter tension opposite the expanded spring (avoiding fuel delivery to stop after the vapour is consumed) when pressure on the plunger is released. The functuality of the fuel and water vapour temperature compensated control valve performs in exactly the same way.

When the engine is cold more fuel is required to run the engine. During this time, the plunger opens wide off its seat, which allows extra fuel to pass through. As heat builds up on the control valve, the plunger progressivly closes down via length wise expansion of the plunger and the spring, so as to cut back the fuel required during warm up of the engine. Consequently this lesser fuel is allowed to vapourise and pressurise in the void of the control valve in sympathy to the spring to restrict or stop fuel entry. In addition, a bias spring temperature compensates the control

valve, to stop the plunger of the control valve from shutting completely (which avoids total engine stoppage during heat build up). The temperature compensated control valves may have an electro-magnet, connected to the micro-processor, from sensors on the accelerator pedal, to over-ride the pressure on the piston to deliver fuel to the outlet of the control valve, into the fuel rail and to the injectors, which is used for stages 3 and 4, to give fast acceleration when required. Fuel from the fuel tank is fed to the temperature compensated control valves by a bypass fuel line through a vacuum controlled diaphragm valve which circulates fuel from the fuel tank and back, depending on engine demand or engine usage of the fuel. This operation also helps keep the fuel in the main delivery line cool, which guards against vapour locks in this main fuel line.

Where an engine has a carburettor fuel bowl, a timer is used to either empty the fuel bowl before switching over to super economy mode (stage 1) or refill before or during startup and during heatup modes. This is used in addition to all the above as before described in this document of this now mentioned fuel delivery system, including the vapour vessels, the temperature compensated control valves, the water vapour system and the engine steam reformer system. The heating system is the same as the above description when an engine has a caburettor with a caburettor fuel bowl. The only two changes the above described device, is (1) it does not have a fuel rail which

supplies the injectors. This is ommited from the caburettor system, since the caburettor system does not have injectors. And (2), as before mentioned, in addition the timer is used, when this fuel supply system is fitted to an engine which has a carburettor.

BRIEF DESCRIPTION OF THE DRAWINGS

To enable the invention to be fully understood, a number of preferred embodiments will now be described with reference to the accompanying drawings in which:

Fig 1 is a schematic layout of the system:

Fig 2 is a schematic sectional side view of a pressure vessel:

Fig 3 is a plan and sectional veiw of a temperature compensated control valve:

Fig 4 is a plan of the engine steam reformer plates and;

Fig 5 is a plan of the water vapour system.

Fig 6 is a plan of the heated fuel rail to the injectors.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to Fig 1, Fig 2, Fig 3, Fig 4, Fig 5, and Fig 6 the fuel supply system 10 incorporates six interconnected systems: The fuel system 11; the watervapour system 53; the engine steam reformer system 54; the micro-processor 12; the temperature compensated control valves (Fig 3, 60); and the accelerator system 13: The fuel system 11 has a fuel tank 14 fitted with an electric fuel pump 15, which pumps fuel under pressure into the petrol line 16. A branch line 17 is fitted with an elctro-magnetic temperature compensated control valve 18 and a temperature compensated control valve

19 and is connected to the fuel rail input (30) of an electronic fuel injection system 20 fitted to a petrol engine 21.

The fuel line 16 is fitted to a temperature compensated control valve 19 and is split into lines 20, 21 which supply the respective pressure vessels 22, 23 via electro-magnetic temperature compensated control valves 24, 25 and temperature compensated control valves 26, 27.

The water vapour system 53 consists of a water tank 57 a water pump 55 to supply water to the water heating radiator 58 and the engine steam reformer system 54.

Referring to Fig 2, each pressure vessel 22, 23 has a closed body with the petrol inlet lines 20, 21 sealed by suitable blocks.

Temperature compensated liquid sensors 36, 37 monitor fuel into the pressure vessels 22, 23. This fuel is vapourised by the heating coils 29 sourounding or within the vapour vessels. Fuel vapour lines 38, 39 from the pressure vessels are provided with a vapour pump 40, 41 and compensated control valves 42, 43 and are connected to a vapour line 44. A metering valve 45 is connected to the fuel vapour input line 44 so as fuel vapour can mix with the steam in the engine steam reformer system 54 which is delivered to the engine 21. The temperature compensated control valves 18, 24, 25, 40 and 41 and the liquid sensors 36, 37 are connected to the micro-processor 46 which is programmable to suit the particular intended application, and a timing circuit and switch 47, 48.

The micro-processor 46 is connected to a

sensor 49 which monitors the position of the accelerator position of the accelerator pedal 50, this sensor 49 also connected to the engine 21 either by a conventional accelerator linkage or an electronic circiut to facilitate the 4 stages of this fuel sytem as before described.

Typical application of each of the temperature compensated control valves (fig 3 60) is that the temperature compensated control valve has a plunger 66 within the control valve body which may have an electro-magnetic means 68 to open or shut the plunger 66. The base of the plunger 66 has a seal 64 and when closed rests on a seat 65 and is held in the closed position by a spring 67, one end of which is located in a recess (not shown) in the top of the plunger 66 with the opposite end of the spring 67 protruding from its recess, which presses against its spring landing. The amount of movement of the plunger 66 is controlled by an ajusting means 69 on the top of the valve body, for adjusting and fine tuning of the spring 67. Within the plunger 66, is a small bore angely 62 through the plunger 66 which allows pressure from the outlet side, to enter through the plunger 66 to close it against the seat 65 in sympathy with the spring 67 and reduces or stops fuel from entering, until the vapour is consumed and or the pressure drops.

To compensate for heat build up, a temperature compensating bias spring 61 is situated between the seal 64 end of the plunger 66 and the seat 65, which prevents the plunger 66 from fully closing onto the seat 65, by applying counter tension opposite the heat

expanded spring, which avoids total stoppage of fuel supply to the engine 21.

The total steam reformer system 54 Fig. 4 and the water vapour system 53 Fig. 5 consists of a water container 57 (20 liters or more), a water vapourising radiator 58, engine steam reformer plates 54 of carbon steel fabricated to fit between the exhaust manifold and the cylinder head of the engine 21 with a series of pipes 59 runing horizontaly through the engine steam reformer 54, which accepts hot exhaust gases to carry water vapour from the heating radiator 58 through a ventury tube 60 into the engine steam reformer system 53 to convert the water-vapour into a steam condition, where the tendency of the hydrogen and oxygen becomes separated and to introduce fuel vapour, wherein the hydrogen separates from the carbon. The carbon joins with the oxygen resulting in carbon dioxide, leaving the hydrogen free to run the engine 21. During stage 2 mode when extra power is required to the engine 21 a small amount of extra fuel is introduced into the engine steam reformer system 54 via temperature compensated control valves (60 Fig. 3.). These operations are controlled by the micro-processor 46 (Fig. 1) which relates directly via sensors 51 to the accelerator pedal 50 of the automobile.

The fuel rail 70 Fig. 6 is manufactured to have nipples 71 attached to it, one nipple per injector of the engine 21 to mix with steam from the engine steam reformer 54 and has a tube 72 running through the centre of it, to carry a flow of exhaust gases drawn through by vacuum from the engine 21, which at the same

time heats the air intake of the engine 21. The circumferance of the inner heat tube 72 is smaller in size than the circumferance of the fuel rail tube 70, with enough clearance to allow fuel in between the inner tube 72 and outer tube 70, but yet restrict the volume of fuel in the fuel rail to readily heat as a fuelet enters the fuel rail 70. The fuel is delivered into the fuel rail 70 through the temperature compensated control valves 60, controlled to open or close by the micro-processor 46 to supply fuel to the engine 21.

The injectors (not shown) of the engine 21 are modified with a shield to protect them from distortion during latent heat, caused by the heat of the crude steam, from the engine steam reformer 54, entering the inlet manifold where the injectors protrude.

It has been found that substantial decrease of fuel usage of an internal combustion engine is evident when fuel and water is heated to steam condition and controlled with the use of temperature compensating control valves that metre fuel and water vapour at its correct proportions, together with the use of a micro-processor. Fuel can be read as to mean any form of hydrocarbon fuel. Water can mean any kind of water that is either filtered or converted on board the motor vehicle so as to become fresh water.

The embodiments described are by way of illustrative examples only, and various changes and modifications may be made thereto without departing from the scope of the invention defined in the appended claims:

CLAIMS:

(1) An ENGINE FUEL METERING AND STEAM REFORMER SYSTEM including:

(2) several vapour vessels;

(3) pump means to supply liquid fuel from a supply to the vapour vessels;

(4) means to heat the vapour vessels to cause the liquid fuel in the vapour vessels to be vapourized;

(5) and means to supply the vapourized fuel to the engine steam reformer system; wherein:

(6) The vapour vessels are arranged in parallel;

(7) and temperature compensated liquid monitor means are provided to selectively connect a temperature compensated control valve, which has a bias spring (to hold it open when heated) to stop complete closer, to control fuel to the vapour vessels by the pump means and the vapour supply means;

(8) so that while one vapour vessel is connected to the vapour supply means to supply the vapourized fuel to the engine steam reformer system, the other vapour vessels are disconnected from the vapour supply means while the liquid fuel in the other vapour vessel is being vapourized;

(9) and a means to supply the vapourised fuel to the engine steam reformer system using temperature compensated control valves according any one claim 7 & 8 and vacuum pump means according to claim 5;

(10) and a means to heat water to water vapour and to convert the water vapour into a crude steam consiting of, in its majority, hydrogen, which is left floating free, from both the fuel and the water vapour, to power the engine:,

(11) A supply system according to Claim 1

wherin:

(12) the intake of the engine is a carburettor a carburettor fuel bowl timer or fuel injection unit and the vapour supply means includes a vapour line having a temperature compensated control valve according to any one claim 7 8 & 9.

(13) A supply system according to Claim 2 wherein:

(14) a petrol line is provided in parallel with the vapour supply means and interconnects a vacuum pump means to the engine steam reformer system via selectively operable temperature compensated control valves according to any one claim 7, 8, 9 & 12.

(15) A supply system according to any one of Claims 1 to 12 wherein:

(16) a respective first temperature compensated control valve selectively connects each vapour vessel to a fuel line from the pump controlled by the temperature compensated liquid level monitor and a respective second temperature compensated control valve connects each vapour vessel to the vapour supply means, which delivers the vapour to the engine steam reformer system according to any one claim 5, 9 & 10.

(17) A supply system according to any one Claim 7, 8, 9 & 12 wherin:

(18) the first temperature compensated control valve of the vapour vessels and the rest of the temperature compensated control valves of the vapour vessels are opened electro-magnetically simultaneously with use the of a microprocessor and the temperature compensated liquid level monitors, while the other temperature compensated control valves being closed and vice versa.

(19) A supply system according to any one Claim 1 to 18 wherein:

(20) the heating means for the vapour vessels, engine steam reformer or water vapour radiator, include induction heaters with coils wound around or inside the vapour vessels which cause metal sourounds, plates or blocks in the vapour vessels, the engine steam reformer plates, the water vapour radiator and the fuel rail to be heated.

(21) A supply system according to any one Claim 1 to 20 wherein:

(22) the heating means include hot exhaust gas, coolant or engine or transmission oil passed through heat exchange coils in the vapour vessels, engine steam reformer plates the water vapour radiator and the fuel rail, electric heating coils within or around and/or microwave heating of the vessels, engine steam reformer plates, the water vapour radiator and the fuel rail.

(23) A supply system according to any one of Claims 1 to 22 wherein:

(24) the system is controlled by an electronic logic control unit which incorporates a micro-processor.

(25) A supply system according to any one Claim 18 & 24 wherein:

(26) the microprocessor control unit is connected to sensors on the accelerator (or throttle) portion and the temperature compensated liquid monitors on the vapour vessels.

(27) A supply system according to any one Claim 7, 18 & 24 wherein:

(28) the microprocessor control unit and the temperature compensated liquid level monitors controls the temperature compensated control

valves and their sequence of opening and closing, to supply fuel in or vapour out, of the vessels.

(29) A supply system according to any one Claim 18, 24,26 & 28 wherein:

(30) the microprocessor control unit incorporates timers which cause the switch over of the vapour vessels at regular intervals or to switch on another vapour vessel, so the one just used can and be recharged ready for use.

(31) An engine fitted with an ENGINE FUEL METERING AND STEAM REFORMER SYSTEM claimed in any one Claim 1 to 30.

(32) An engine fuel supply system including:

(33) several vapour vessels;

(34) means to supply liquid fuel to the vapour vessels alternatively;

(35) means to heat the vapour vessels to vaporize the liquid fuel;

(36) and a means to supply the vaporized fuel to the engine steam reformer system alternatively from the each vapour vessel, where liquid fuel is supplied to the vapour vessels while the other vapour vessel supplies the vaporized fuel to the engine steam reformer system which converts the steam and the fuel into a crude steam, leaving the hydrogen floating free to power the engine according to any one claim 7, 9, 10 & 16.

(37) a supply system according to any one claim 5, 7, 9, 10, 20, & 26 whereby;

(38) a heated fuel rail is used to provide 2 extra power stages to the engine by delivering heated fuel through the use of temperature compensated control valves and the microprocessor to mix with the steam from the engine steam reformer system.

(39) An engine fitted with an ENGINE FUEL METERING AND STEAM REFORMER SYSTEM according to any one claim 1 to 38 wherein:

(40) Fuel is to be construed as meaning any fuel containing hydrocarbon and/or is hydrocarbon.

(41) Water vapour is derived from a water tank mounted on the vehicle, which is pumped through the water vapour system and thence into the engine steam reformer system. This water can be any type which is coverted to fresh water through the filtering system on board the vehicle.

(42) An engine fitted with an ENGINE FUEL METERING AND STEAM REFORMER SYSTEM as outlined in and according to any one claim 1 to 41.

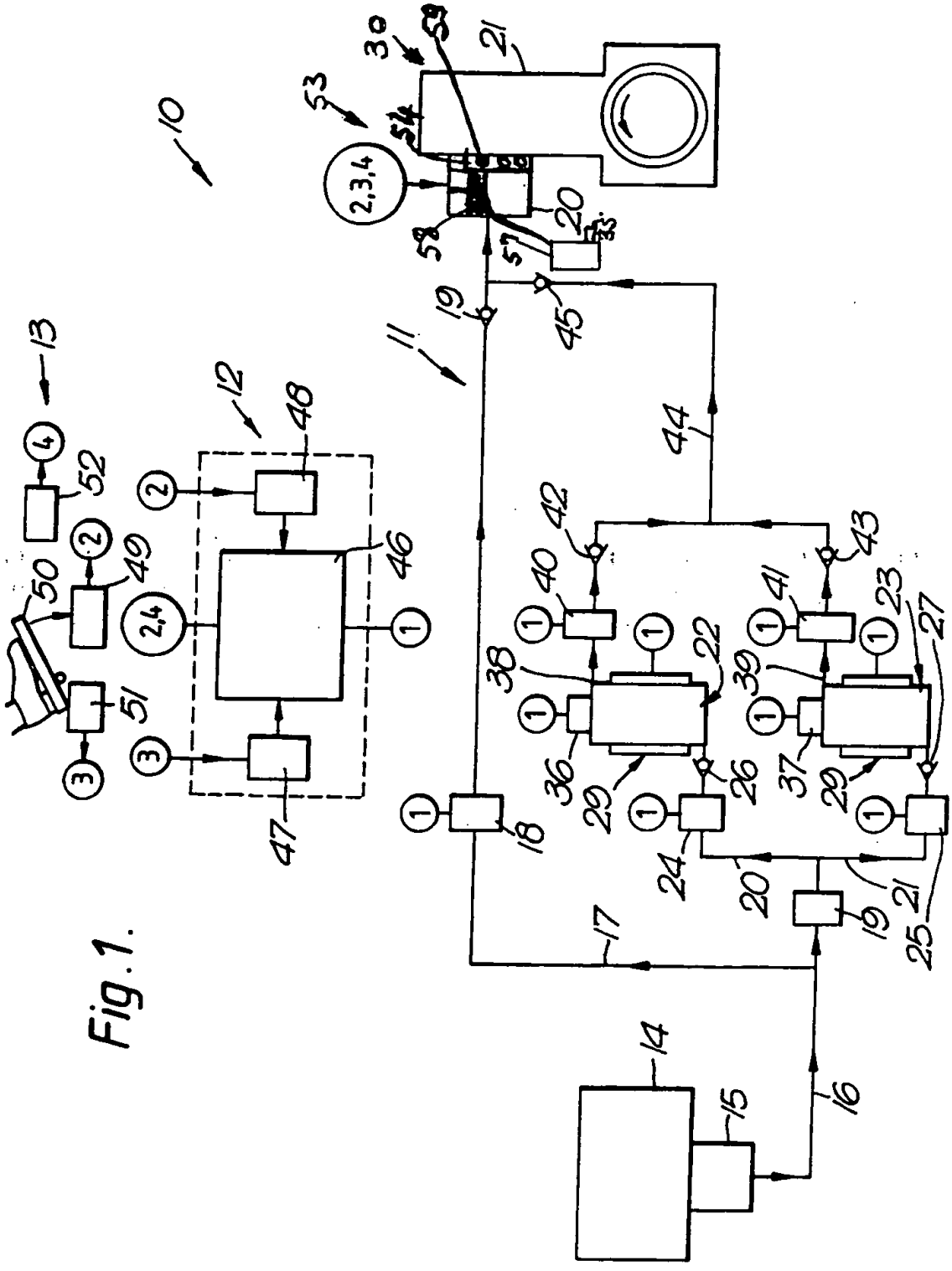
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Fig. 1.

Fig.2.

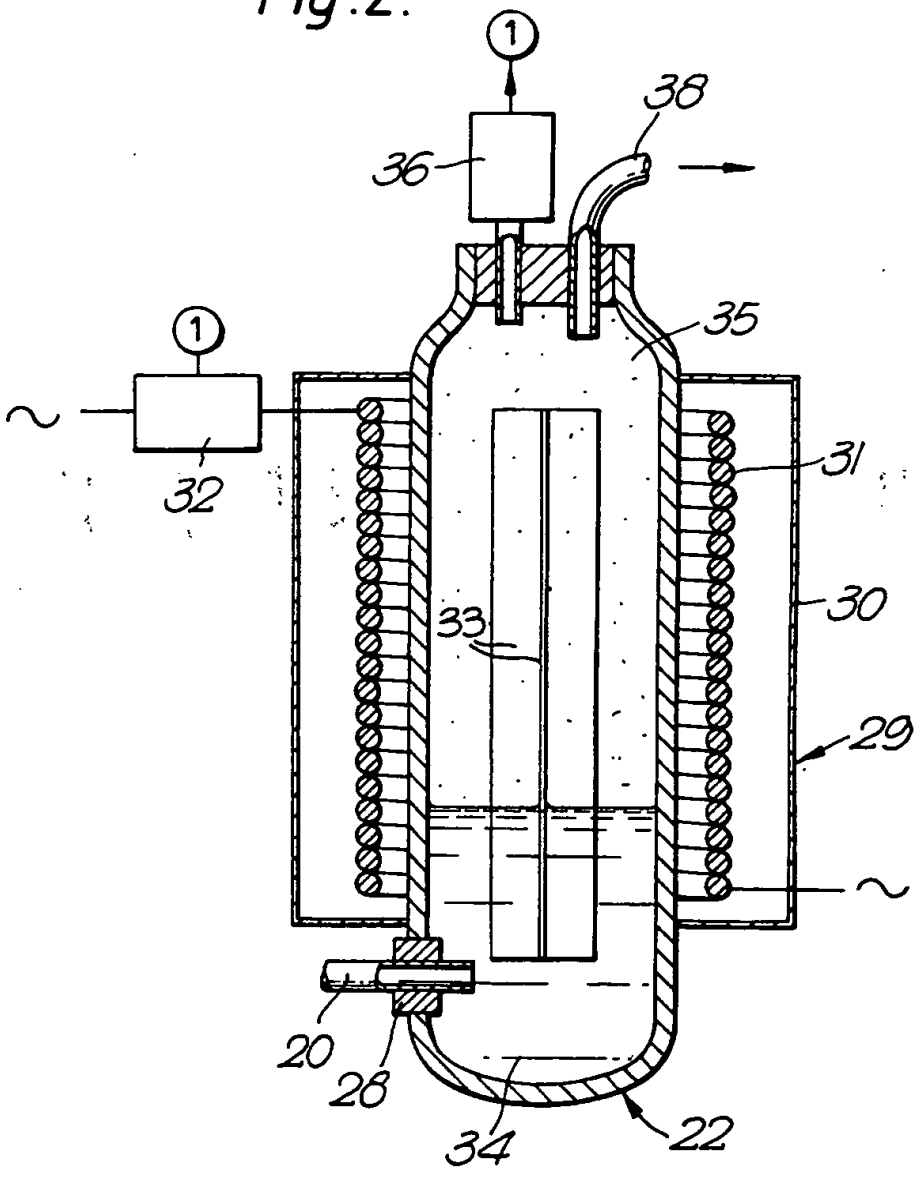
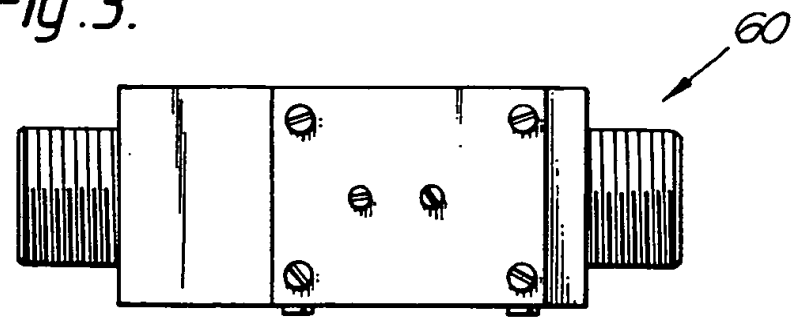
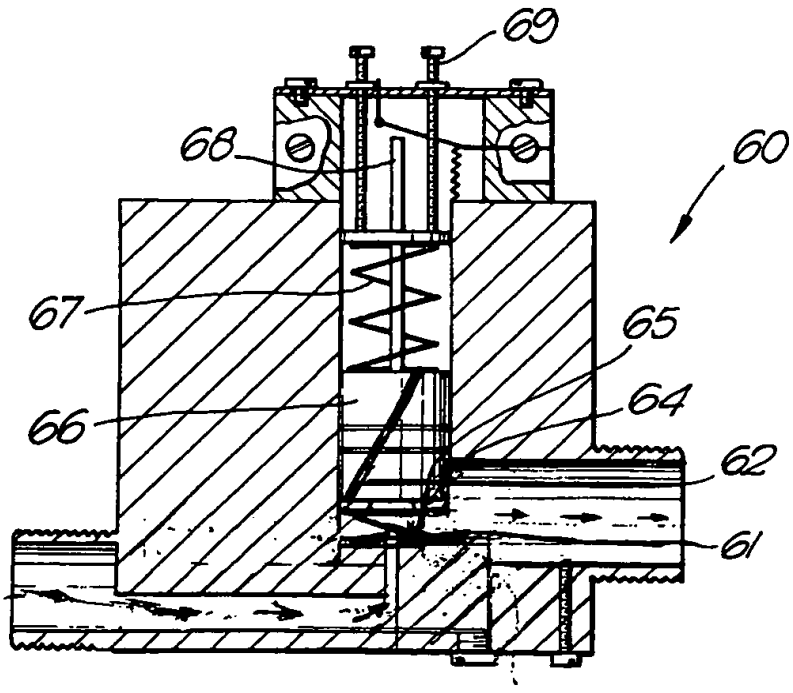


Fig.3.





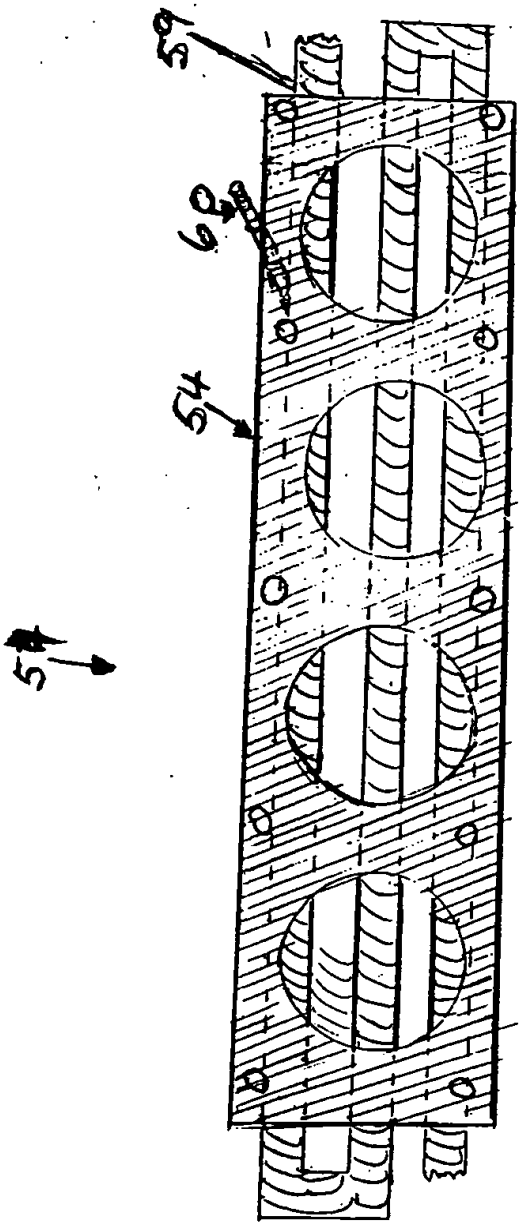


Fig. 4.

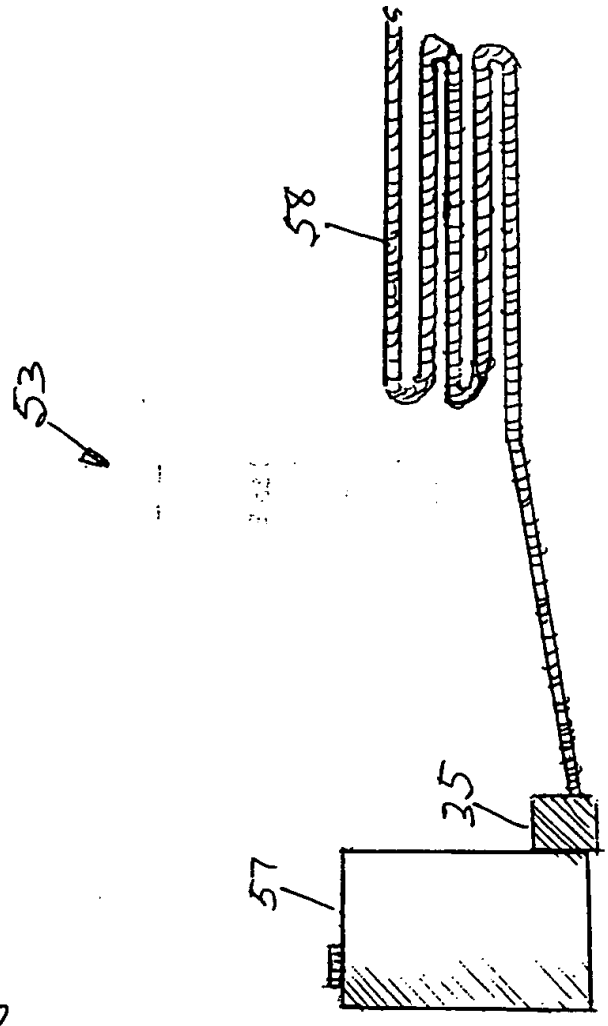


Fig. 5

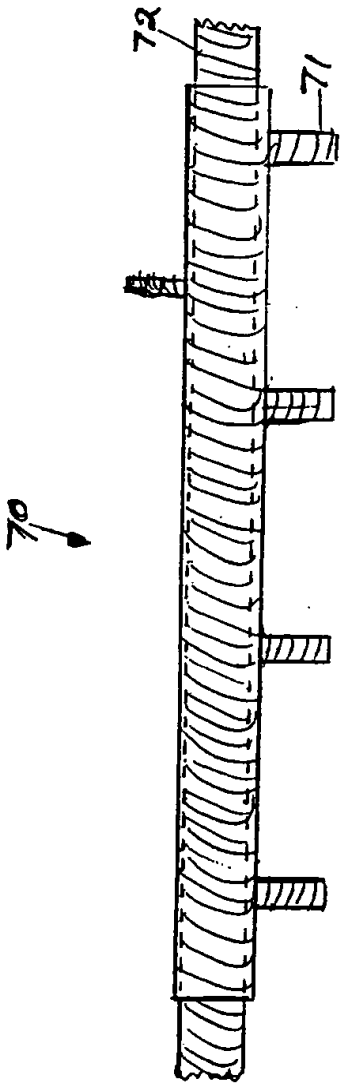


Fig. 6.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 93/00629

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] F02M 31/18, 25/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC:F02M 31/18, 25/02, F02B 47/02: covering the period 1985 to date
This search relies on the International Search conducted in respect of WO,A,87/01766 (cited below), which covers the scope of the present claims: covering the period 1920-1985

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU:IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)
DERWENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	WO,A,87/01766 (SMITH) 26 March 1987 (26.03.87) cited in the international application.	
A	entire document	1-31, 37-38
Y		32-36, 39-42
	Patent Abstracts of Japan, M 568, page 142, JP,A,61-229967 (MATSUURA) 14 October 1986 (14.10.86)	
Y	abstract	32-36, 39-42
	Patent Abstracts of Japan, M 1267, page 10, JP,A,4-66757 (TAKUMA SOUGOU KENKIYUUSHIYO K.K.) 3 March 1992 (03.03.92)	
A	abstract	1-42

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 April 1994 (26.04.94)	6 May 1994 (06.05.94)
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	Authorized officer C.M. WYATT Telephone No. (06) 2832538

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INTERNATIONAL SEARCH REPORT
information on patent family membe.

International application No.
PCT/AU 93/00629

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
WO 8701766	AU 63791/86

END OF ANNEX